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Description

This invention relat s to syst ms and mark rs using magn tic or spin r sonance phenomena for practical purposes. More particularly, but not exclusively, it is concerned with the use of magnetic resonance, spin resonance and spin-echo phenomena in systems for the surveillance, recognition, detection, sorting or monitoring of articles, stock or personnel. The applications of such systems include electronic article surveillance (theft prevention) and personnel verification.

The magnetic resonance phenomena are associated with nuclear, electron, atomic or molecular magnetic dipole moments acting individually or cooperatively in the presence of magnetic fields to give nuclear magnetic resonance (NMR), nuclear quadrupole resonance (NQR), electron spin resonance or electron paramagnetic resonance (ESR, EPR), ferromagnetic resonance, ferrimagnetic resonance, antiferromagnetic resonance, domain wall resonance, spin-wave resonance or spin-echoes. For convenience, the term 'magnetic resonance' will be used herein to include all of these magnetic and spin phenomena. The magnetic resonance is exhibited when the dipole moments precessing in the magnetic fields absorb and re-radiate microwave or radio frequency electromagnetic radiation at or very close to the precession frequency.

It is known from Electro Conference Record, 24th-26th April, 1979, vol. 4, J.R. Gonano: "Nuclear Magnetic Resonance and Nuclear Quadrupole Resonance for Bomb Detection" pp. 1-5 to use NMR and NQR techniques to detect explosives in suitcases. The suitcases are carried through a magnetic field on a conveyor belt, and subjected to NMR and/or NQR scans in order to determine the presence or absence of explosives in the suitcases.

EP 0 228 692 discloses a skin marker for use in medical diagnosis by means of both X-ray tomography and nuclear magnetic resonance imaging. This skin marker is used for steric correlation of an X-ray image of a part of a patient's body with an NMR image of the same region of the patient's body. It is necessary for the marker to be free of ferromagnetic materials, as these interfere with the NMR imaging. Furthermore, there is no suggestion of selecting the magnetic characteristics of such a marker so as to generate an individually identifiable frequency response and thereby to distinguish between and identify different markers.

A variety of electronic article surveillance or personnel d tection systems currently xist. They involve d tection of macroscopic magnetic prop rties r macroscopic resonances associated with LC electrical circuit res nances, or with bulk m chanical vibrational resonances, or with non-linear l ctrical transponders or with high-permeability magn tically saturating soft magn tic elements.

An xample of a d tection system mploying magn tostrictive resonance is disclos d in EP 0 096 182. This type of system empl ys a mark r for articl surveillance comprising elongated strips of a magnetostrictive material arranged to undergo macroscopic physical resonance at a frequency of around 15 kHz when subjected to an oscillating magnetic field in a detection zone. A ferromagnetic element disposed adjacent to each of the strips of magnetostrictive material is adapted, upon being magnetized, to magnetically bias the strips and thereby arm them to resonate at their preselected frequencies.

EP-A-0 215 605 discloses a detection system which includes a marker containing an inductive-capacitive resonant circuit. The marker is made reversibly deactivatable and reactivatable by the addition of a piece of magnetic material that forms a magnetic circuit enclosing the inductive component, and by means, such as a piece of permanently magnetizable material, for controllably magnetically biasing the magnetic material. The detection system further includes an interrogation zone in an exit-way comprising antennas for generating and receiving radio frequency signals. Upon passage within the zone of an object to which is affixed a marker, the marker, when in its sensitized state, will be excited to produce oscillations at its resonance frequency.

Materials exhibiting the atomic resonance phenomena described above can be used in accordance with this invention for article recognition and/or detection and for security surveillance. Such use is possible because they can have extremely sharply defined resonant frequencies, which may be used to indicate their presence or identity. This can be achieved in a preferred embodiment of the invention by the use of a microwave or radio frequency emitting interrogation system which also detects an increase in the absorption of the interrogating electromagnetic energy or reemission of electromagnetic energy by the marker at the resonant frequency.

According to one aspect of this invention, there is provided a method of electronic article or personnel surveillance which comprises monitoring, recognising or detecting the location of an article, or sorting or selecting an article from a plurality of articles, or personnel identification, wherein said article or personnel is tagged with a marker comprising a material which supports a predetermined resonance property which serves to identify said article or personnel, which method is characterised in that said resonance is magnetic resonance and in that the method comprises th st ps of:

i) subjecting said magnetically resonant mat rial simultaneously to a static magn tic field and to l ctromagnetic radiation;

ii) obs rving a magn tic resonance property by d t cting th abs rption or r mission of said

electromagnetic radiation by said marker at characteristic magnetic resonance frequencies; and

iii) correlating said observed magnetic resonance property with said predetermined magnetic resonance property in order to identify said article or personnel.

Generally, a marker for use in the method of the invention will be provided with means whereby the marker can be attached to an article or body (e.g. a person) the location of which is to be monitored, recognised or detected or which is to be sorted or selected from a plurality of articles or bodies.

According to a second aspect of the present invention, there is provided a marker for use in the method of the first aspect, which marker comprises a substrate which supports internally or externally a plurality of magnetically active regions, of which at least one region comprises a material selected to support a predetermined magnetic resonance property, and of which at least one other region comprises a permanent or semi-permanent magnet, wherein said material is electrically non-conductive and said magnetic resonance is electron spin resonance (ESR).

According to a third aspect of the present invention, there is provided a marker for use in the method of the first aspect, which marker comprises a substrate which supports internally or externally a plurality of magnetically active regions, of which at least one region comprises a material selected to support a predetermined magnetic resonance property, and of which at least one other region comprises a permanent or semi-permanent magnet, wherein said material is electrically non-conductive and said magnetic resonance is nuclear magnetic resonance (NMR).

According to a fourth aspect of the present invention, there is provided the use of a marker in the method of the first aspect, which marker comprises a substrate which supports internally or externally a plurality of magnetically active regions, of which at least one region comprises a material selected to support a predetermined magnetic resonance property, and of which at least one other region comprises a permanent or semi-permanent magnet, wherein said material is electrically non-conductive.

The preferred magnetic resonance phenomena for the purposes of the present invention are ESR and spin echoes. The invention will be described hereinafter with particular reference to these phenomena, although it is to be understood that the invention is not restricted to systems or articles which make use only of these phenomena. The modifications necessary to practise the invention using other magnetic resonance phenomena, e.g. NMR or ferrimagnetic resonance, will be apparent to those skilled in the art.

The magnetic field required to produce defined resonances can be supplied either as a large field over the entire interrogation volume, or by a small permanent or semi-permanent magnet placed close to the resonant material and carried round with it and the article. Thus in one embodiment a permanent or semi-permanent magnet and the resonant material are fabricated as a unit which constitutes the detectable marker. In this embodiment it may still be advantageous to impose a small externally-generated magnetic field. This can be a d.c. field to counteract, for example, the Earth's field. Alternatively a small a.c. field operating at a low frequency, typically of a few kHz, can be used to scan repeatedly across resonance at this identifiable second frequency.

Markers in accordance with the present invention are distinct and identifiable (and different markers may be fabricated so as to have a unique magnetic resonance signature) since the combination of the resonating material and an established magnetic field is sufficiently unique to give a resonance which will not occur with everyday objects (or with other markers in accordance with this invention).

The resonant material may be a solid, or a solid solution, or a solid/liquid solution, or a liquid/liquid solution.

According to a fifth aspect of the present invention, there is provided a detection system including a marker as defined above, which system comprises a gate which, in use, will be located at a point of sale location or between a point of sale location and an exit from the premises containing said point of sale location, wherein said gate comprises means for emitting radiation in the microwave or radiofrequency waveband; and means for detecting radiation emitted by the marker in response to a magnetic field in conjunction with said microwave or radiofrequency radiation.

According to a sixth aspect of the present invention, there is provided the use of a detection system in the method of the first aspect, including the use of a marker as defined above, which system comprises a gate which, in use, will be located at a point of sale location or between a point of sale location and an exit from the premises containing said point of sale location, wherein said gate comprises means for emitting radiation in the microwave or radiofrequency waveband; and means for detecting radiation emitted by the marker in response to a magnetic field in conjunction with said microwave or radiofrequency radiation.

The microwave radiation is preferably pulsed so that absorption by the marker is time-differentiated from emission of radiation from the active atoms within the marker due to decay of the excited ESR or NMR state. Detection of emitted radiation thus indicates presence of a marker which has not been removed by an assistant at the point of sale.

Examples of materials which can be used for ESR detection include paramagnetic salts - i.e. salts containing paramagnetic ions, for example Cu^{2+}, Mn^{2+}, Fe^{3+}, Gd^{3+}, Cr^{3+}, Tb^{3+}, Er^{3+} - in particular transition group metal ions of the iron group, the palladium group, the platinum group, and the actinide group. In

addition, certain organic mol cules or stable fre radicals hav an unpaired l ctron and are paramagnetic - xamples are naphthalen , nitroxides, diph nyl picryl hydrazyl, and triph nyl m thyl. Crystallin s lids containing ionic impurities are also suitable, as well as certain naturally occuring minerals exemplified by ultramarine.

The active paramagnetic moieties in the magnetically resonant material are preferably spaced apart from one another on the atomic scale in order to minimise coupling between neighbouring paramagnetic ions and hence give a more sharply defined resonance. Thus salts containing paramagnetic metal ions are advantageously used in dilute form, for example dispersed to 1% dilution (by weight) in a diamagnetic salt or medium, for example in magnesium oxide.

Compounds containing nuclei with a net nuclear spin, such as hydrogen, carbon, nitrogen, chlorine, phosphorus, magnesium and calcium, can all be used for NMR detection. Isotopes with low natural abundance will give improved discrimination against false alarms.

When the marker comprises a resonant material attached to or adjacent to a permanent or semi-permanent magnet, the magnetic material is advantageously a crystalline metal, an amorphous metal, or a crystalline or powdered ferrite-type material such as that used in magnetic recording media. The magnet may be a permanent magnet - i.e. have very high coercivity; or a semi-permanent, switchable magnet - preferably one with coercivity between $100Am^{-1}$ and $50,000Am^{-1}$. The magnetic material may also be a composite of materials of differing properties designed to produce a high intensity, uniform field.

The marker may comprise a magnet in the form of a sheet of material placed over or underneath the resonant material or, preferably, the resonant material and the magnet may be substantially co-planar. In one preferred embodiment, the resonant material is adjacent to the tips or edges of a strip or sheet of the magnetic material, or placed in a small gap in an annulus or toroid of the magnetic material.

In further embodiments of the marker, a magnetic material is intimately mixed with the resonant material to form a magnetic matrix around it, or the magnetic material is used to encapsulate the resonant material.

In one embodiment of marker, there is a plurality of magnetically active regions arranged physically so as to generate a unique magnetic resonance signal when the marker is interrogated with a predetermined magn tic field.

In certain embodiments it is advantageous to assemble the marker in such a way that th magn tic field from th magnetic material is f high amplitud and very uniform across th sample of the resonant mat rial. This k eps th resonant signal sharp - i.e. narrow and of maximum amplitud . Further embodiments with this advantag ous property will b obvious to those skilled in the design of magnetic systems.

The resonance frequency shown by the resonant material depends, amongst other parameters, on the strength of the magnetic field in which it is placed. If a magnetic field of non-uniform spatial distribution is applied to the material, then different regions of the material will have different resonance frequencies. In another embodiment of this invention this spread of frequencies is used to compensate for any manufacturing variations in the marker of this invention, or in a detection system for identifying such a marker; the same effect can also compensate for any unknown or unpredictable external magnetic field (for example the Earth's field) which might affect the magnetic field which is deliberately applied by the detection system to generate a specific resonance in the marker.

In such instances of resonance where the orientations of the magnetic field with respect to the microwave radiation or the interrogation apparatus is critical to the amplitude of the resonance, the magnetic element in the marker or the detection system may be arranged to generate a diverging magnetic field in order to increase the number of different orientations at which magnetic field lines intersect the marker.

In one embodiment of the second aspect of this invention as defined above, the marker carrying a plurality of magnetically active regions (which may, for example, comprise soft magnetic regions, semi-hard magnetic regions and hard magnetic regions as well as the magnetically resonant material) is used in conjunction with a suitable detection system, whereby the magnetic field generated within the marker by the field applied by the detection system is inhomogeneous and has a specific and characteristic form. This result may be achieved by using, in the marker, portions of resonant material positioned so that when subjected to the applied field of the detection system, they are located at points or regions having a different field gradient. The same result may also be achieved with a marker including several small ferromagnetic elements between a major magnetically active region (e.g. a strip of a magnetically soft material) and the resonant material. The result in such cases is that the range and frequencies of the resonant responses from the marker can be used as information representing a code which is a further distinguishing feature of the identity of the resonant element or of the article or body carrying the marker. This allows markers of this invention to be used for article coding. In one embodiment this coding may be altered by positioning sampl s of th res nant material at vari us distances from a magn tic el ment or plurality of lements of fix d magn tisation. If a plurality of resonant lem nts is us d to g n rat a plurality of distinguishable resonances, then various combinations of posi-

tion and hence of resonances will represent different id ntifier codes.

In anoth r mbodiment the positions of the resonant lem nts are fixed, but they are placed cl s to a plurality of magnetically switchable semi-permanent magnetic elements so that the magnetic environment of the resonant elements can be altered in a non-contact fashion by changes in an external, applied magnetic field. With a variety of magnetic elements of different coercivities, the identifier codes may be altered by this method in a controlled manner.

Magnetic resonant materials can also exhibit echo phenomena such as spin echoes or ferromagnetic echoes under certain conditions. One class of these echo phenomema rely on non-linear coupling mechanisms between energy storage modes in the materials, and the amplitude of the echo is sensitive to a number of parameters such as strain in the material, the shape of the sample, the homogeneity of the magnetic field in the sample, and the time delay for excitation of the echo.

These materials can be used as parametric amplifiers dependent on any of these properties, and this characteristic can be used in security or identification systems. The echo is manifested as a microwave echo emitted by the sample in response to a microwave pulse or train of pulses incident on the material, usually following a specific time after the final incident pulse. In one embodiment, the spin echo relies upon magnetoelastic (or magnetostrictive) coupling of energy to mechanical vibrations of the detectable marker, and the spin-echo delay time can be made to depend upon the dimensions of the marker.

As a further example, the echo delay time may depend upon the shape of a sample or crystal of the material, with a randomly-shaped crystal showing a number of echo delays or echo resonances with a variety of amplitudes. These can be used to distinguish an individual crystal of the material. It is a characteristic of one class of spin echo that the echo is enhanced by irregular shape of the crystal and by an inhomogenous magnetic field. This type of echo is particularly suited to implementation in manufactured detectable markers, where inhomogeneity and irregularity are likely to occur.

If the crystal is produced in a way which is difficult to reproduce, then a unique identifier code can be generated. This can be used to identify an individual person or article which carries the crystal in a security system. An example of the production of a crystal of unique shape is to shatter a very small crystal, and then use individual random shards. The shards can b interrogated r motely by microwaves, and v ry small volumes can b d tected und r resonant echo excitation.

In anoth r embodim nt, the spin echoes are excited by two shorter bursts of l ctromagnetic energy at the resonant frequ ncy separated by a time t_1. A third, echo respons results at the sam time interval t_1 after the s cond burst as a r sult of the evolution of the magn tisation resulting from constructiv int rfer nce of precessing magnetic spins induced by the two interrogation pulses in the spin system. The time t_1 is carefully chosen with reference to the spin relaxation times of the magnetically resonant moiety in order to maximise the amplitude of the echo which indicates the presence of the marker material. In order to generate a strong echo signal it is advantageous if the excitation pulse duration t_p is short compared to one cycle time t_r of the resonant frequency, and furthermore if both t_p and t_1 are much shorter than the spin relaxation or decay times for the aligned spin system. Maximal spin echo amplitude is observed if t_p/t_r is approximately 1/3.

The echo delay time may be several microseconds, with the shape and amplitude of the echo as a function of time dependent on the input signal shape. Both of these characteristics may be used as identifiers of the presence of the spin-echo material. Phenomena which can be used for this application include ferromagnetic echoes, ferrimagnetic echoes, spin wave echoes and antiferromagnetic echoes. The materials which exhibit these phenomena may be crystalline, amorphous, multiphase or composite manufactured materials. Particular examples of materials which show these echo phenomena are yttrium iron garnet and yttrium aluminium garnet.

The extreme sharpness of the resonance exhibited by certain substances exhibiting magnetic resonances can be exploited to advantage in two embodiments of the invention. The narrow resonance indicates a low damping or loss in the oscillating spin systems, which may also be expressed as a high oscillatory quality factor, or Q-factor. This in turn may be viewed as a high effective gain, leading to an anomalously high absorption of energy from the interrogating electromagnetic field at or near to resonance. This sharp resonant absorption is highly characteristic of the marker material. In one embodiment of the invention, this absorption, from a continuously applied interrogating field, is detected to indicate the presence of the marker.

The high Q-factor is also manifested as a prolonged emission of electromagnetic energy from the marker at a characteristic frequency (the resonant frequency) or frequencies after the interrogating electromagnetic field has been switched off. According to another preferred embodiment, the interrogation field is pulsed on for short periods of time and then switched off. The characteristic emission from the marker continues after the excitation has been stopped, and is detected a f w microseconds or ven milliseconds later. Particular uniqueness associated with the mark r can also b derived from m asuring th phase of this mission and/or th sp cific way in which th amplitude and phase evolves in time. This

latter embodiment is particularly useful wher the dynamic rang in the detection syst m limits th ability to detect small amounts of absorption from a continuously applied int rrogation fi ld. It will b clear to those skilled in the art that the spin echo phenomema described above can be exploited in accordance with this invention by the use of interrogation fields which are pulsed in an appropriate manner, and where detection is carried out some time after the interrogation pulses. Methods for implementing these embodiments, such as detection of a phase shift during absorption, use of bridged detectors, and pulsing techniques, are well known in the art, and will not be described in detail.

It is usually of advantage in theft-prevention systems and other systems in accordance with this invention to be able to leave the detectable marker on the protected object or person when it is legitimately purchased or otherwise legitimately moved through the detection zone. Because of this it is desirable to have a means for deactivating or disarming the detectable marker.

According to a seventh aspect of this invention there is provided a method of electronic article or personnel surveillance as defined above, further characterised in that said marker may be deactivated by a predetermined alteration of the magnetic resonance properties of said magnetically resonant material. The means for deactivating the resonant material may be a deactivation zone provided on or in the marker itself; or it may be an element which responds directly or indirectly to an externally applied force so as to alter the chemical, crystallographic, or physical nature of the detectable marker. In one embodiment the resonance frequency is altered by inducing a chemical or crystallographic change in the resonant material. These changes alter the local atomic environments of the magnetic dipoles and hence their effective magnetic moments. The change in resonance frequency leads either to the marker not being detected in the expected bandwidth of the detection system, or to the altered frequency being recognized as characteristic of disarmed markers. Chemical or physical changes can also be used in a similar fashion to lower the quality factor of the resonant species, i.e. to destroy the resonance, sufficiently for the marker to be no longer detectable, and hence to deactivate it. Suitable techniques to induce these changes are heating by an electromagnetic or particle beam, or by friction, cooling, release of a reactive chemical agent onto the resonant material, dissolving in a solvent, or physically breaking up the material.

In another embodiment, th deactivation is carried out by changes to th magnetic fi ld of th magnetic element. This is achi ved by a d gaussing magn tic fi ld, by heating or mechanical working or a combination of th two, by physically breaking up the configuration of th magnetic material, or by changing the direction or amplitude of the magnetisation in th magnetic lement in th region of the resonant material by applying an xternal field to the lement or to secondary lements close to the main element. Even small changes in the magnetic field at the resonant material will lead to detectable changes in the resonant frequency, and hence to an indication of deactivation.

The selection of appropriate marker materials and of suitable deactivation regimes for the selected material will be made so as to be congruent with the intended application. Thus for antipilferage tags intended for use in retail establishments, a thermal or magnetic deactivation system will generally be used in preference to one requiring the use of reactive chemicals.

For a better understanding of the present invention, preferred embodiments will now be described by way of example, with reference to the accompanying drawings in which:

Figures 1 and 2 show examples of configurations of a detectable marker;

Figure 3 shows a schematic diagram illustrating the configuration of magnetic field lines in one embodiment of detectable marker;

Figure 4 shows further examples of detectable marker configuration;

Figure 5 shows a schematic diagram of the generation of a spin-echo pulse of electromagnetic radiation;

Figure 6 shows an exploded view of a detectable marker incorporated into an antipilferage tag;

Figure 7 shows schematically a system for detecting a concealed detectable marker; and

Figure 8 shows a schematic representation of a radiofrequency or microwave system suitable for generation and detection of characteristic "identity" signals emanating from a detectable marker of this invention.

Referring first to Figure 1, a resonant material 1 and a magnetising material 2 are substantially planar. The detectable marker may have a variety of configurations. In Figure 1a, material 1 is contained in the gap in an annulus of material 2, the magnetic material preferentially being magnetised circumferentially to generate a high magnetic field across the gap. In Figure 1b, small samples of the resonant material 1 are placed at the tips of a sheet or strip of the magnetic material 2, which is preferentially magnetised longitudinally to produce a high magnetic field across the resonant material. It will be clear that these configurations may equally well be implemented as substantially 3-dimensional structures - i. . as toroids or rods or blocks. However, laminar structures ar preferred since they are more easily incorporated into inobtrusive markers.

R ferring to Figur 2, th resonant material 1 is incorporated, mix d, or encapsulated with th mag-

netic material 2 in order to improve the magnetic field coupling to mat rial 1. In this and in other mbodim nts it is advantageous to use circular, spherical, elliptical, or g nerally llipsoidal shaped samples of the resonant material in order to improve the uniformity of the magnetic field across the sample.

Referring next to Figure 3, the magnetic field 3 generated by the magnetic material 2 is shown schematically to be diverging over the region of the resonant material 1. This may be exploited in the manner described hereinbefore to give a variety of resonant conditions within a single sample of material 1, both as regards orientation of the magnetic moments with respect to the detection apparatus, and as regards the exact value of the resonant frequency.

Figure 4 shows how diverging fields of the type shown in Figure 3 may be further exploited by placing a plurality of elements 1 of resonant material in positions which are either magnetically equivalent or magnetically different around the magnetising material 2. It will be clear that the plurality of elements 1 may also be implemented as a single extended element. With careful positioning of a plurality of elements, a number of relatively discrete resonance conditions may be established. This multiplicity of different resonances may be used as described hereinbefore to generate a unique identifier code attributable to a single article, person, or group of articles or people.

Figure 5 shows the time evolution of electromagnetic energy during generation of a spin-echo pulse. The height of the pulses represents the amplitude of the electromagnetic field, and the horizontal axis shows time. Pulse 1 and pulse 2, each of width t_p, are applied by the pulsed external radiofrequency or microwave source at a time interval t_1. The resonant material produces a discrete response pulse at a time t_1 after the second pulse, and this response pulse is detected to indicate the presence of the detectable marker.

Figure 6 shows how a detectable marker of the type shown in Figure 1 may be incorporated into an antipilferage tag or an identifying marker. The components 1 and 2 comprising the marker are placed onto a substrate 4, or manufactured by direct deposition on the substrate. The substrate 4 may be a sheet of paper or polymer or other flexible material, or a non-flexible sheet or block of supporting material. The underside of the substrate may be covered in a layer of glue or other fixing agent or mechanism to secure it to the object to be marked or protected. In addition, to conceal the purpose of the marker, a face covering or face paper 5 may be laminated to the mark r.

Figure 7 shows a schematic of the identification or detecti n of the passage of a concealed mark r 6 which is attach d to som protect d article 7. A microwav or radiofrequency source mits lectromagnetic radiation 9. Th absorption of energy due to th presence of the marker or th re-emission of nergy by th mark r is d t cted by one or more microwav r radiofr qu ncy receivers 10.

Referring t Figure 8, LPF repres nts a low-pass filter, PSD represents a phase sensitive detector, and 'Amp' represents signal amplifier. The gates are electronic switches to rapidly switch the transmission or reception on or off, to enable the system to work in a pulsed mode. The switch timing is controlled by the timing generator, and may be implemented either by PIN diodes or by a combination of circulators and PIN switches to give extremely fast switching times (less than 0.2ns).

In the receive circuit, the limiter is necessary to protect the first amplifier (preferably a low noise amplifier) from residual leakage of transmit signal through the receiver gate in its off condition.

The combination of two phase sensitive detectors in quadrature allows full measurement of the phase of the signal. The phase and amplitude characteristics of the signal are analysed by the computer or processing unit to assess if a marker is present.

For continuous, rather than pulsed, operation, the electronic gates in the circuit are not necessary. In this case the local oscillator may be swept frequency oscillator, producing an interrogation frequency which sweeps across the expected range of the marker resonance frequency.

The invention will be illustrated further in non-limiting fashion by the following Examples.

EXAMPLE 1

This Example describes the construction of an antipilferage marker comprising a magnetic material and a resonant material, assembled onto a substrate. The magnetic material is a semi-permanent magnet made from Vacozet, a proprietary material produced by Vacuumschmeltze of West Germany. This material has a high remanent magnetization and is manufactured with a variety of coercive forces. In the chosen embodiment, material with a coercive force of $3{,}000\text{Am}^{-1}$ was used, although this choice is not critical - a coercive force of over $10{,}000\text{Am}^{-1}$ can be used. Alternatively, other magnetic materials such as nickel or magnetic stainless steels may be used in this embodiment as the magnetic element. An annulus of thickness 40 µm, diameter 10mm, and track width 3mm is punched from a sheet of the material and stuck to a substrate of paper coated with a pressure-sensitive glue. Approximately 1mg of a powder in the form of an impermeable resin containing small crystals of diphenyl picryl hydrazyl of diameter approximat ly 100 µm is th n placed centrally in the gap in the magnetic annulus, and the marker is then cover d with a prot ctive lay r of paper. Th composite is th n cut to a square label of dimensions 12mm X 12mm. The r sonant material xperiences a magnetic field of

approximately 30mT, and has an electron spin resonant frequency of approximately 1GHz with a resonance half width less than 1MHz, indicating a decay time after excitation of more than 1 microsecond. The magnetic material in this Example was chosen so that a degaussing field of maximum amplitude of the order of 10,000 A/m could be used to deactivate the marker (by altering the resonant properties of the resonant material).

EXAMPLE 2

This Example is similar to Example 1 in that the magnetizing element is constructed in the same manner. However, the resonant material in this Example consists of small spheres, 100 μm in diameter, of yttrium iron garnet. In this case the material shows a ferromagnetic resonance at 1GHz with a quality factor of approximately 5,000 giving a decay time, again, of more than 1 microsecond.

EXAMPLE 3

In this Example, the resonant material is the same as in Example 1 or Example 2, but the magnetic material is replaced by a permanent magnetic material. Alcomax is a suitable proprietary material, as is Ferroba, a barium ferrite. These materials are deposited in the form of a powder slurry mixed with a thermosetting resin, and printed in a layer approximately 100 μm thick. The material is magnetized by placing it close to a permanent magnet or by a pulsed current in a coil adjacent to or threading the annulus. Finally the slurry is set by gentle heating of the glue, to fix the direction of magnetization.

Claims

1. A method of electronic article or personnel surveillance which comprises monitoring, recognising or detecting the location of an article, or sorting or selecting an article from a plurality of articles, or personnel identification, wherein said article or personnel is tagged with a marker (6) comprising a material (1) which supports a predetermined resonance property which serves to identify said article or personnel, which method is characterised in that said resonance is magnetic resonance and in that the method comprises the steps of:
   i) subjecting said magnetically resonant material simultaneously to a static magnetic field and to electromagnetic radiation (9);
   ii) observing a magnetic resonance property by detecting the absorption or re-emission of said electromagnetic radiation by said marker at characteristic magnetic resonance frequencies; and
   iii) correlating said observed magnetic resonance property with said predetermined magnetic resonance property in order to identify said article or personnel.

2. A marker for use in the method of claim 1, which marker comprises a substrate (4) which supports internally or externally a plurality of magnetically active regions, of which at least one region comprises a material (1) selected to support a predetermined magnetic resonance property, and of which at least one other region comprises a permanent or semi-permanent magnet (2), wherein said material (1) is electrically non-conductive and said magnetic resonance is electron spin resonance (ESR).

3. A marker for use in the method of claim 1, which marker comprises a substrate (4) which supports internally or externally a plurality of magnetically active regions, of which at least one region comprises a material (1) selected to support a predetermined magnetic resonance property, and of which at least one other region comprises a permanent or semi-permanent magnet (2), wherein said material (1) is electrically non-conductive and said magnetic resonance is nuclear magnetic resonance (NMR).

4. A marker as claimed in claim 2, wherein said material (1) is a salt including paramagnetic ion.

5. A marker as claimed in claim 4, wherein said paramagnetic ion is Cu^{2+}, Mn^{2+}, Fe^{3+}, Gd^{3+}, Cr^{3+}, Tb^{3+}, Er^{3+}.

6. A marker as claimed in claim 4 or 5, wherein said paramagnetic ion is used in dilute form, dispersed in a diamagnetic medium.

7. A marker as claimed in claim 6, wherein said diamagnetic medium is magnesium oxide.

8. A marker as claimed in claim 2, wherein the resonant material is an organic molecule or a stable free radical.

9. A marker as claimed in claim 2, wherein the resonant material is a crystalline solid containing ionic impurities.

10. A marker as claimed in claim 8, wherein said resonant material is naphthalene, a nitroxide, diphenyl picryl hydrazyl, or triphenyl methyl.

11. A marker as claimed in claim 2, wherein said magnetic resonance is ferromagnetic resonance,

f rrimagnetic resonance, antif rromagnetic resonance or domain wall resonanc .

12. A marker as claimed in claim 2, wher in said magnetic resonance is spin-echoes.

13. A marker as claimed in claim 2, wherein said magnetic resonance is spin-wave resonance.

14. A marker as claimed in any of claims 2 to 13, wherein the marker is fabricated as a laminar item.

15. A marker as claimed in any of claims 2 to 14, wherein the marker includes a semi-permanent, switchable magnet with a coercivity in the range 100 A/m to 50,000 A/m.

16. A marker as claimed in any of claims 2 to 15, wherein the resonant material (1) is located adjacent to the tips or edges of the magnetic material (2).

17. A marker as claimed in any of claims 2 to 15, wherein the resonant material (1) is located in a gap in an annulus or toroid of magnetic material (2).

18. A marker as claimed in any of claims 2 to 15, wherein the resonant material (1) is located within the bulk of the magnetic material (2).

19. A marker as claimed in any of claims 2 to 18, wherein the configuration of magnetic material (2) and resonant material (1) is such as to provide a substantially uniform magnetic field throughout the resonant material.

20. A marker as claimed in claim 19, wherein the resonant material (1) is a circular, spherical, elliptical or generally ellipsoidal shaped sample.

21. A marker as claimed in any one of claims 14 to 18, wherein the configuration of magnetic material (2) and resonant material (1) is such as to provide a substantially divergent magnetic field (3) across the resonant material.

22. A marker as claimed in claim 2, 3 or 4, wherein the plurality of magnetically active regions is arranged physically so as to generate a unique magnetic resonance signal when the marker is interrogat d with a predetermined magnetic fi ld and lectromagnetic radiati n.

23. A mark r as claimed in claim 12, wh rein th resonant material (1) is arranged to undergo magnetostrictive coupling with mechanical vibrations of the marker.

24. A marker as claim d in claim 23, wherein th resonant material (1) is a crystal of irr gular shap .

25. A detection system including a marker (6) as claimed in any one of claims 2 to 24, which system comprises a gate which, in use, will be located at a point of sale location or between a point of sale location and an exit from the premises containing said point of sale location, wherein said gate comprises means (8) for emitting radiation (9) in the microwave or radiofrequency waveband; and means (10) for detecting radiation emitted by the marker (6) in response to a magnetic field in conjunction with said microwave or radiofrequency radiation (9).

26. A detection system as claimed in claim 25, wherein said means (8) for emitting microwave or radiofrequency radiation (9) is arranged to emit pulses of radiation.

27. A detection system as claimed in claim 26, which further includes means for detecting the waveform of radiation emitted by the marker (6) in response to microwave or radiofrequency radiation (9).

28. A detection system as claimed in claims 25, 26 and 27, wherein said gate further comprises means for producing a gate-generated magnetic field across the gate; and means for detecting the resonance response of the marker (6) to said microwave or radiofrequency radiation (9) in conjunction with said gate-generated magnetic field.

29. A method according to claim 1, further characterised in that said marker (6) may be deactivated by a predetermined alteration of the magnetic resonance properties of said magnetically resonant material (1).

30. A method according to claim 29, wherein said predetermined alteration comprises inducing a chemical or crystallographic change in said magnetically resonant material (1) in order to change said resonance properties.

31. A method according to claim 29, wherein said predetermined alteration comprises inducing a chemical or physical change in said magnetically resonant material (1) in rder to low r the quality factor of said magnetically resonant mat rial (1).

32. A method according to claims 29, 30 or 31, wherein said changes ar induced through heating by an l ctromagn tic or particle b am, or by

friction, cooling, rel ase of a r activ chemical agent onto said magnetically resonant mat rial (1), dissolving said magnetically r sonant material (1) in a solv nt, or physically breaking up said magnetically resonant material (1).

33. A method according to claim 29, wherein said predetermined alteration comprises inducing a change in the magnetic field to which said magnetically resonant material (1) is subjected.

34. A method according to claim 33, wherein said change is induced by applying a degaussing magnetic field to, by heating and/or mechanically working, by physically breaking up, or by applying an external magnetic field to a permanent or semi-permanent magnet (2) which is provided in or on said marker (6) in addition to said magnetically resonant material (1).

Patentansprüche

1. Verfahren zum elektronischen Überwachen von Gegenständen oder Personen, umfassend das Aufzeichnen, Erkennen oder Erfassen des Gegenstandorts oder das Sortieren oder Auswählen eines Gegenstandes aus einer Anzahl Gegenstände oder die Personenidentifizierung, wobei der Gegenstand oder die Person mit einem Kennzeichner (6) verbunden ist, der ein Material (1) enthält, das eine vorbestimmte Resonanzeigenschaft unterstützt, die zum Identifizieren des Gegenstandes oder der Person dient, wobei das Verfahren dadurch gekennzeichnet ist, daß die Resonanz eine Magnetresonanz ist und die Schritte umfaßt:
   i) Aussetzen des Magnetresonanzmaterials unter die gleichzeitige Wirkung eines statischen Magnetfelds und elektromagnetischer Strahlung (9);
   ii) Beobachten einer Magnetresonanzeigenschaft durch Erfassen der Absorption oder Reemission der elektromagnetischen Strahlung durch den Kennzeichner bei charakteristischen Magnetresonanzfrequenzen; und
   iii) Korrelieren der beobachteten Magnetresonanzeigenschaft mit der vorbestimmten Magnetresonanzeigenschaft, um den Gegenstand oder die Person zu identifizieren.

2. Kennzeichner zum Gebrauch im Verfahren nach Anspruch 1, wobei der Kennz ichn r in Substrat (4) enthält, das intern od r extern eine Anzahl magn tisch aktiver Ber iche trägt, von d nen mindestens in B r ich in Mat rial (1) enthält, das ausg wählt wurd , um ein vorbestimmt Magnetresonanzeig nschaft aufzuweisen, und von denen mind st ns ein and rer Ber ich in n Perman nt- oder Halbp rmanentmagn t (2) enthält, w b i das Mat rial (1) l ktrisch nichtleitend und di Magnetresonanz Elektronenspinresonanz (ESR) ist.

3. Kennzeichner zum Gebrauch im Verfahren nach Anspruch 1, wobei der Kennzeichner ein Substrat (4) enthält, das intern oder extern eine Anzahl magnetisch aktiver Bereiche trägt, von denen mindestens ein Bereich ein Material (1) enthält, das ausgewählt wurde, um eine vorbestimmte Magnetresonanzeigenschaft aufzuweisen, und von denen mindestens ein anderer Bereich einen Permanent- oder Halbpermanentmagnet (2) enthält, wobei das Material (1) elektrisch nichtleitend und die Magnetresonanz Kernmagnetresonanz (NMR) ist.

4. Kennzeichner nach Anspruch 2, wobei das Material (1) ein Salz mit einem paramagnetischen Ion ist.

5. Kennzeichner nach Anspruch 4, wobei das paramagnetische Ion Cu^{2+}, Mn^{2+}, Fe^{3+}, Gd^{3+}, Cr^{3+}, Tb^{3+} oder Er^{3+} ist.

6. Kennzeichner nach Anspruch 4 oder 5, wobei das paramagnetische Ion in verdünnter Form verwendet wird, verteilt in einem diamagnetischen Medium.

7. Kennzeichner nach Anspruch 6, wobei das diamagnetische Medium Magnesiumoxid ist.

8. Kennzeichner nach Anspruch 2, wobei das Resonanzmaterial ein organisches Molekül oder ein stabiles, freies Radikal ist.

9. Kennzeichner nach Anspruch 2, wobei das Resonanzmaterial ein kristalliner Feststoff ist, der Ionenverunreinigungen enthält.

10. Kennzeichner nach Anspruch 8, wobei das Resonanzmaterial Naphthalin, ein Stickstoffoxid, Diphenylpikrylhydrazyl oder Triphenylmethyl ist.

11. Kennzeichner nach Anspruch 2, wobei die Magnetresonanz ferromagnetische Resonanz, ferrimagnetische Resonanz, antiferromagnetische Resonanz oder Domänenwandresonanz ist.

12. Kennzeichner nach Anspruch 2, w bei die Magnetresonanz Spinechos sind.

13. Kennzeichner nach Anspruch 2, wobei di Magnetresonanz Spinwellen-Resonanz ist.

14. K nnzeichner nach irgendeinem der Ansprüche 2 bis 13, wob i der Kennz ichn r als blattförmiger Gegenstand hergest llt wird.

15. Kennzeichner nach irgendeinem der Ansprüche 2 bis 14, wobei der Kennzeichner einen halbpermanenten, schaltbaren Magnet mit einer Koerzitivität im Bereich von 100 A/m bis 50000 A/m enthält.

16. Kennzeichner nach irgendeinem der Ansprüche 2 bis 15, wobei das Resonanzmaterial (1) nahe bei den Spitzen oder Kanten des Resonanzmaterials (2) angeordnet ist.

17. Kennzeichner nach irgendeinem der Ansprüche 2 bis 15, wobei das Resonanzmaterial (1) in einem Spalt in einem Ring oder Toroid aus Magnetmaterial (2) angeordnet ist.

18. Kennzeichner nach irgendeinem der Ansprüche 2 bis 15, wobei das Resonanzmaterial (1) innerhalb des Volumens des Magnetmaterials (2) angeordnet ist.

19. Kennzeichner nach irgendeinem der Ansprüche 2 bis 18, wobei das Magnetmaterial (2) und das Resonanzmaterial (1) so angeordnet sind, daß sie im Resonanzmaterial durchgehend ein im wesentlichen gleichförmiges Magnetfeld bereitstellen.

20. Kennzeichner nach Anspruch 19, wobei das Resonanzmaterial (1) ein kreisförmiges, kugelförmiges, elliptisches oder allgemein ellipsoidisch geformtes Einzelstück ist.

21. Kennzeichner nach irgendeinem der Ansprüche 14 bis 18, wobei das Magnetmaterial (2) und das Resonanzmaterial (1) so angeordnet sind, daß sie im Resonanzmaterial durchgehend ein im wesentlichen divergentes Magnetfeld (3) bereitstellen.

22. Kennzeichner nach Anspruch 2, 3 oder 4, wobei die Anzahl magnetisch aktiver Bereiche physikalisch so angeordnet ist, daß ein unverwechselbares Magnetresonanzsignal erzeugt wird, wenn der Kennzeichner mit einem vorbestimmten Magnetfeld und elektromagnetischer Strahlung abgefragt wird.

23. Kennzeichner nach Anspruch 12, wobei das Resonanzmaterial (1) so ang ordnet ist, daß es einer magn tostriktiven Kopplung mit mechanischen Schwingungen d s Kennzeichners unterliegt.

24. Kennzeichner nach Anspruch 23, wobei das Resonanzmaterial (1) in Kristall von unregelmäßiger Gestalt ist.

25. Erfassungssystem, umfassend in n Kennz ichner (6) nach irgendeinem der Ansprüche 2 bis 24, wobei das System einen Durchgang enthält, der bei Gebrauch an einer Verkaufsstelle angeordnet ist oder zwischen einer Verkaufsstelle und einem Ausgang der Räumlichkeiten, in denen sich die Verkaufsstelle befindet, und der Durchgang eine Einrichtung (8) zum Aussenden von Strahlung (9) im Mikrowellen- oder Hochfrequenzband enthält sowie eine Einrichtung (10) zum Erfassen der Strahlung, die der Kennzeichner (6) als Reaktion auf ein Magnetfeld in Verbindung mit der Mikrowellen- oder Hochfrequenzstrahlung (9) aussendet.

26. Erfassungssystem nach Anspruch 25, wobei die Einrichtung (8) zum Aussenden von Mikrowellen- oder Hochfrequenzstrahlung (9) zum Aussenden von Strahlungsimpulsen eingerichtet ist.

27. Erfassungssystem nach Anspruch 26, das zudem eine Einrichtung enthält, geeignet zum Erkennen der Wellenform der Strahlung, die der Kennzeichner als Reaktion auf Mikrowellen- oder Hochfrequenzstrahlung (9) abgibt.

28. Erfassungssystem nach Anspruch 25, 26 und 27, wobei der Durchgang ferner eine Einrichtung umfaßt, geeignet zum Herstellen eines vom Durchgang erzeugten Magnetfelds überall im Durchgang und eine Einrichtung zum Erfassen der Resonanzantwort des Kennzeichners (6) auf die Mikrowellen- oder Hochfrequenzstrahlung (9) in Verbindung mit dem vom Durchgang erzeugten Magnetfeld.

29. Verfahren nach Anspruch 1, zudem dadurch gekennzeichnet, daß der Kennzeichner (6) durch eine vorbestimmte Änderung der Magnetresonanzeigenschaften des Magnetresonanzmaterials (1) deaktiviert werden kann.

30. Verfahren nach Anspruch 29, wobei die vorbestimmte Änderung das Herbeiführen einer chemischen oder kristallographischen Änderung im Magnetresonanzmaterial (1) umfaßt, um die Resonanzeigenschaften zu ändern.

31. Verfahren nach Anspruch 29, wobei die vorbestimmt Änderung das Herb iführen einer chemisch n oder physikalischen Änderung im Magnetresonanzmaterial (1) umfaßt, um den Beschaffenheitsfaktor des Magnetresonanzmat rials (1) zu verringern.

32. Verfahren nach den Ansprüch n 29, 30 oder 31, wobei di Änderungen herb igeführt werden durch H iz n mit einem elektromagn tisch n Strahl oder in m Teilchenstrahl oder durch Reibung, Kühlung, Freigeben einer reaktiven chemischen Substanz auf das Magnetresonanzmaterial (1), Auflösen des Magnetresonanzmaterials (1) in einem Lösungsmittel oder durch physikalisches Zerbrechen des Magnetresonanzmaterials (1).

33. Verfahren nach Anspruch 29, wobei die vorbestimmte Änderung einen Wechsel im Magnetfeld umfaßt, dem das Magnetresonanzmaterial (1) ausgesetzt ist.

34. Verfahren nach Anspruch 33, wobei der Wechsel herbeigeführt wird durch das Anlegen eines entmagnetisierenden Magnetfelds, durch Erhitzen und bzw. oder mechanisches Bearbeiten, durch physikalisches Zerbrechen oder durch Anlegen eines äußeren Magnetfelds an einen Permanent- oder Halbpermanentmagnet (2), der in oder auf dem Kennzeichner zusätzlich zum Magnetresonanzmaterial (1) bereitgestellt ist.

Revendications

1. Procédé de surveillance électronique d'articles ou de personnes qui comprend le contrôle, la reconnaissance ou la détection de la position d'un article, ou le tri ou la sélection d'un article parmi un ensemble d'articles, ou l'identification de personnes, dans lequel ledit article ou lesdites personnes est marqué par un marqueur (6) comportant un matériau (1) qui présente une propriété de résonance prédéterminée servant à identifier ledit article ou lesdites personnes, lequel procédé est caractérisé en ce que ladite résonance est une résonance magnétique et en ce que le procédé comprend les étapes consistant à :
   i) soumettre simultanément ledit matériau magnétiquement résonant à un champ magnétique statique et à un rayonnement électromagnétique (9);
   ii) observer une propriété de résonance magnétique par détection de l'absorption ou de la réémission dudit rayonnement électromagnétique par ledit marqueur à des fréquences de résonance magnétique caractéristiques; et
   iii) corréler ladite propriété de résonance magnétiqu obs rvé avec ladite propriété de résonance magnétique prédét rminée pour identifier ledit article ou lesdites p rsonn s.

2. Marqueur destiné à être utilisé dans le procédé selon la r vendication 1, lequ l marqueur contient un substrat (4) qui présente intérieurem nt ou extéri urement un nsembl de régions magnétiquem nt activ s, dont au moins une région comporte un matériau (1) sél ctionné pour présenter une propriété de résonance magnétique prédéterminée, et dont au moins une autre région comporte un aimant permanent ou semi-permanent (2), dans lequel ledit matériau (1) est électriquement non conducteur et ladite résonance magnétique est une résonance de spin électronique (RSE).

3. Marqueur destiné à être utilisé dans le procédé selon la revendication 1, lequel marqueur comporte un substrat (4) qui présente intérieurement ou extérieurement un ensemble de régions magnétiquement actives, dont au moins une région comporte un matériau (1) sélectionné pour présenter une propriété de résonance magnétique prédéterminée, et dont au moins une autre région comporte un aimant permanent ou semi-permanent (2), dans lequel ledit matériau (1) est électriquement non conducteur et ladite résonance magnétique est une résonance magnétique nucléaire (RMN).

4. Marqueur selon la revendication 2, dans lequel ledit matériau (1) est un sel contenant un ion paramagnétique.

5. Marqueur selon la revendication 4, dans lequel ledit ion paramagnétique est un ion Cu^{2+}, Mn^{2+}, Fe^{3+}, Gd^{3+}, Cr^{3+}, Tb^{3+}, Er^{3+}.

6. Marqueur selon les revendications 4 ou 5, dans lequel ledit ion paramagnétique est utilisé sous une forme diluée, dispersée dans un milieu diamagnétique.

7. Marqueur selon la revendication 6, dans lequel ledit milieu diamagnétique est l'oxyde de magnésium.

8. Marqueur selon la revendication 2, dans lequel le matériau résonant est une molécule organique ou un radical libre stable.

9. Marqueur selon la revendication 2, dans lequel le matériau résonant est un solide cristallin contenant des impuretés ioniques.

10. Marqueur selon la revendication 8, dans lequel l dit matériau résonant est le naphtalène, un xyde d'azote, un diphényl picryl hydrazyl , ou un triphényl méthyle.

11. Marqu ur selon la r vendication 2, dans lequel ladit résonance magnétique est un résonance

ferromagnétiqu , une résonance ferrimagnétique, une résonance antif rromagnétiqu ou un résonance sur les parois du domaine.

12. Marqueur selon la revendication 2, dans lequel ladite résonance magnétique est une résonance par échos de spin.

13. Marqueur selon la revendication 2, dans lequel ladite résonance magnétique est une résonance à ondes de spin.

14. Marqueur selon l'une quelconque des revendications 2 à 13, dans lequel le marqueur est réalisé sous la forme d'un article laminaire.

15. Marqueur selon l'une quelconque des revendications 2 à 14 dans lequel, le marqueur comprend un aimant semi-permanent commutable ayant une coercivité dans la gamme de 100 A/m à 50000 A/m.

16. Marqueur selon l'une quelconque des revendications 2 à 15, dans lequel le matériau résonant (1) est situé de façon adjacente aux extrémités ou des bords du matériau magnétique (2).

17. Marqueur selon l'une quelconque des revendications 2 à 15, dans lequel le matériau résonant (1) est situé dans un interstice ménagé dans un anneau ou un tore en matériau magnétique (2).

18. Marqueur selon l'une quelconque des revendications 2 à 15, dans lequel le matériau résonant (1) est situé à l'intérieur de la masse du matériau magnétique (2).

19. Marqueur selon l'une quelconque des revendications 2 à 18, dans lequel la configuration du matériau magnétique (2) et du matériau résonant (1) est propre à fournir un champ magnétique sensiblement uniforme dans tout le matériau résonant.

20. Marqueur selon la revendication 19, dans lequel le matériau résonant (1) est un échantillon de forme circulaire, sphérique, elliptique ou globalement ellipsoïdale.

21. Marqueur selon l'une quelconque des revendication 14 à 18, dans lequel la configuration du matériau magnétique (2) et du matériau résonant (1) est propre à fournir un champ magnétique sensibl m nt div rgent (3) à trav rs le matériau résonant.

22. Marqueur s lon l s revendications 2, 3 u 4, dans lequel l' nsemble de régions magnétiqu ment actives st agencé physiquem nt de façon à générer un signal de résonanc magnétiqu uniqu lorsqu le marqueur est int rrogé par un champ magnétique et un rayonn ment électromagnétiqu prédéterminés.

23. Marqueur selon la revendication 12, dans lequel le matériau résonant (1) est agencé de façon à être soumis à un couplage magnétostrictif par des vibrations mécaniques du marqueur.

24. Marqueur selon la revendication 23, dans lequel le matériau résonant (1) est un cristal de forme irrégulière.

25. Système de détection comprenant un marqueur (6) selon l'une quelconque des revendications 2 à 24, lequel système comporte un portillon qui, lorsqu'il est utilisé, est placé en un point de vente ou entre un point de vente et une sortie du local contenant ledit point de vente, dans lequel ledit portillon comprend un moyen (8) pour émettre un rayonnement (9) dans la bande des hyperfréquences ou des radiofréquences; et un moyen (10) pour détecter le rayonnement émis par le marqueur (16) en réponse à un champ magnétique, en association avec ledit rayonnement hyperfréquence ou radiofréquence (9).

26. Système de détection selon la revendication 25, dans lequel ledit moyen (8) servant à émettre un rayonnement hyperfréquence ou radiofréquence (9) est conçu pour émettre des impulsions de rayonnement.

27. Système de détection selon la revendication 26, comportant en outre un moyen pour détecter la forme d'onde du rayonnement émis par le marqueur (6) en réponse au rayonnement hyperfréquence ou radiofréquence (9).

28. Système de détection selon les revendications 25, 26 et 27, dans lequel ledit portillon comprend en outre un moyen pour produire un champ magnétique généré par le portillon et traversant le portillon; et un moyen pour détecter la réponse en résonance du marqueur (6) audit rayonnement hyperfréquence ou radiofréquence (9) en association avec ledit champ magnétique généré par le portillon.

29. Procédé selon la revendication 1, caractérisé en outre en ce que ledit marqueur (6) peut être désactivé par une altération prédéterminée des propriétés de résonance magnétiqu dudit matériau magnétiquement résonant (1).

30. Procédé selon la r vendication 29, dans lequ l ladite altération prédéterminée compr nd l'induc-

tion d'une modification chimique ou cristallographique dans ledit matériau magnétiquem nt résonant (1) afin d modifier lesdites propriétés d résonanc .

31. Procédé selon la revendication 29, dans lequel ladite altération prédéterminée comprend l'induction d'une modification chimique ou physique dudit matériau magnétiquement résonant (1) afin d'abaisser le facteur de qualité dudit matériau magnétiquement résonant (1).

32. Procédé selon les revendications 29, 30 ou 31, dans lequel lesdites modifications sont induites par chauffage par un faisceau électromagnétique ou de particules, ou par frottement, refroidissement, libération d'un agent chimique réactif sur ledit matériau magnétiquement résonant (1), dissolution dudit matériau magnétiquement résonant (1) dans un solvant, ou rupture physique dudit matériau magnétiquement résonant (1).

33. Procédé selon la revendication 29, dans lequel ladite altération prédéterminée comprend l'induction d'une modification du champ magnétique auquel ledit matériau magnétiquement résonant (1) est soumis.

34. Procédé selon la revendication 33, dans lequel ladite modification est induite par application d'un champ magnétique de démagnétisation, d'un chauffage et/ou d'un usinage mécanique, d'une rupture physique, ou par application d'un champ magnétique externe à un aimant permanent ou semi-permanent (2) qui est disposé dans ou sur ledit marqueur (6) en plus dudit matériau magnétiquement résonant (1).

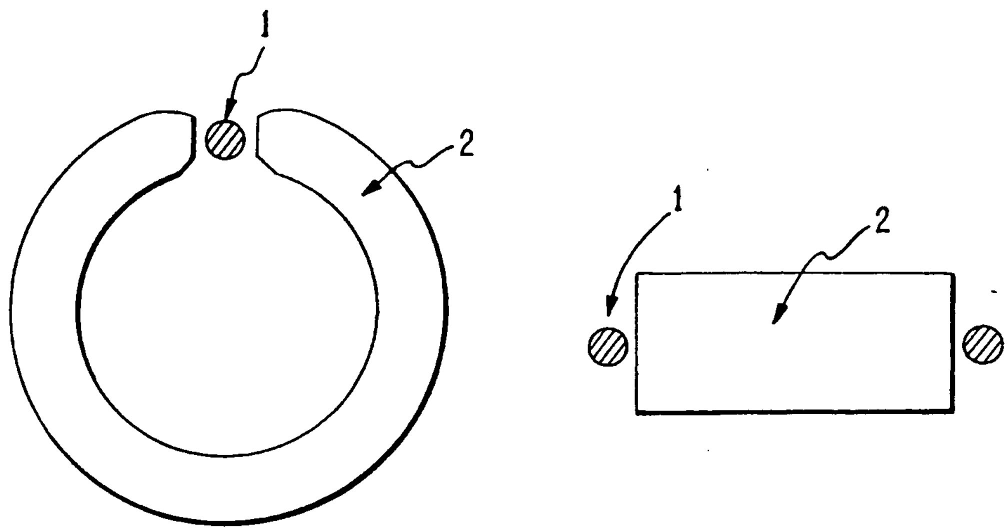

FIG.1

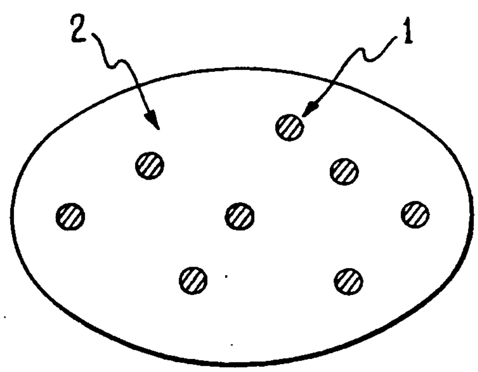

FIG.2

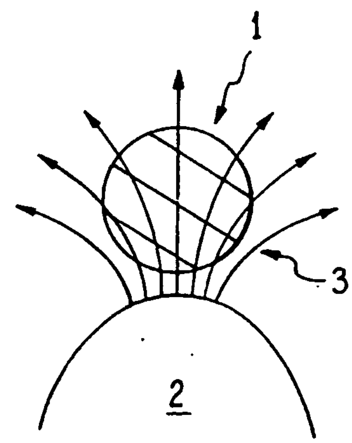

FIG.3

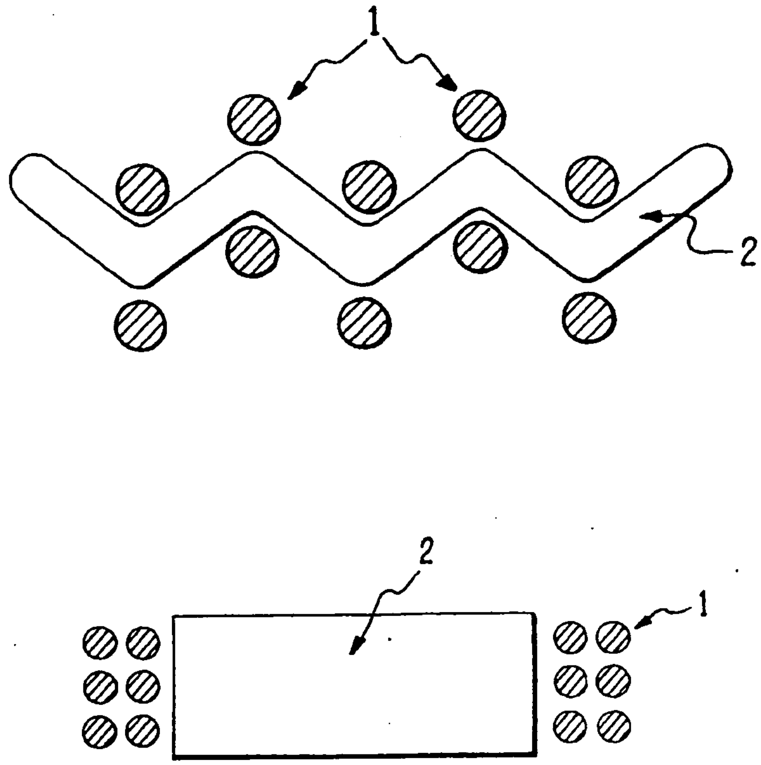

FIG.4

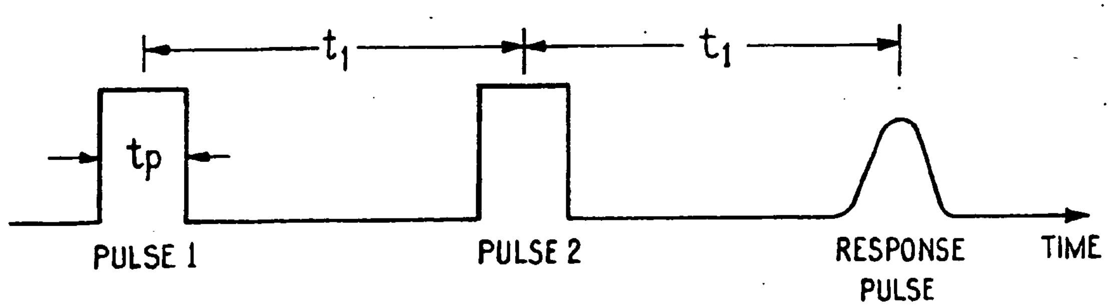

FIG.5

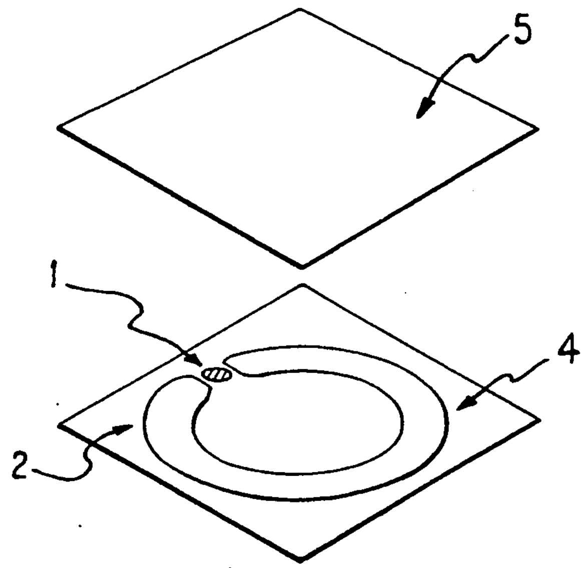

FIG.6

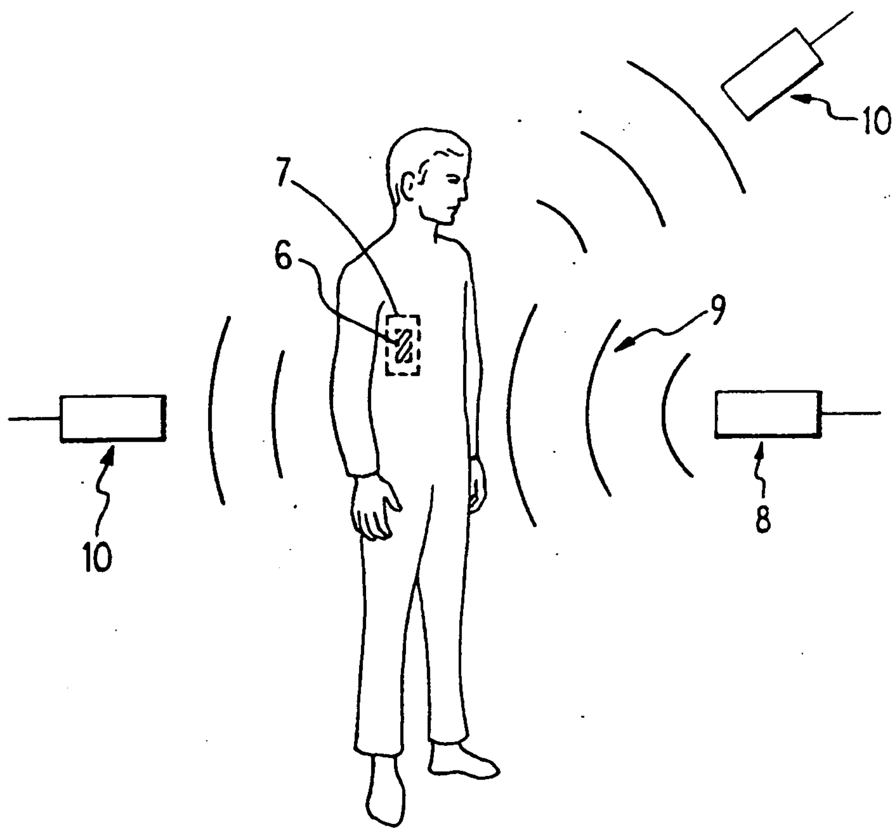

FIG.7

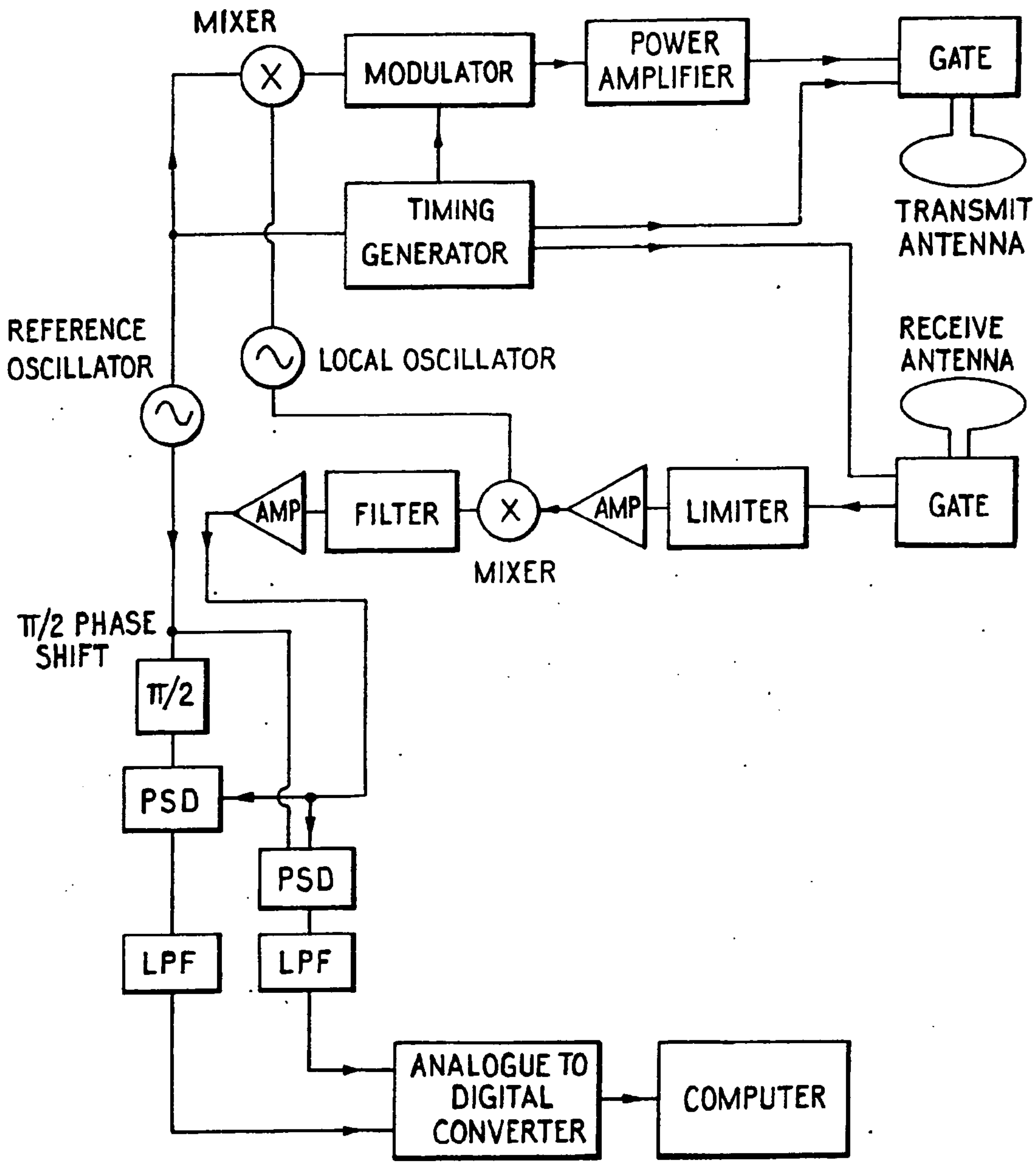
MIXER
MODULATOR
POWER AMPLIFIER
GATE
TRANSMIT ANTENNA
TIMING GENERATOR
REFERENCE OSCILLATOR
LOCAL OSCILLATOR
RECEIVE ANTENNA
AMP
FILTER
AMP
LIMITER
GATE
MIXER
π/2 PHASE SHIFT
π/2
PSD
PSD
LPF
LPF
ANALOGUE TO DIGITAL CONVERTER
COMPUTER

FIG.8